Gambling Task (fMRI Revision 3.0.1)

Marc Grushcow
NTT Systems Inc

Contract Scientific Authority:
Dr. David R. Mandel

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Author

Marc Grushcow

Approved by

Dr. David R. Mandel

DRDC Scientific Authority

Approved for release by

K. C. Wulterkens

for Chair, Document Review and Library Committee

Abstract

The fMRI Gambling Task is a program that presents the subject with two or more decks of cards, where each card has a value associated with it. The task accumulates the value of the selected cards and the subject's goal is to make this value as large as possible. This version of the Gambling Task is designed for use in an fMRI environment. Consequently, a number of features have been added to manage timing considerations and input device characteristics.

Résumé

Le fMRI Gambling Task est un programme qui présente au sujet deux jeux de cartes ou plus dont chacune des cartes est associée à une valeur. La tâche consiste à accumuler la valeur des cartes choisies et le sujet vise à augmenter cette valeur autant que possible. La version de Gambling Task est conçue pour utilisation dans un environnement de d'IRMf (imagerie par résonance magnétique fonctionnelle). Par conséquent, un certain nombre de fonctions ont été ajoutées pour gérer les contraintes de temps et les caractéristiques des unités d'entrée.

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Executive Summary

Gambing Task (fMRI Revision 3.0.1)

[Marc Grushcow]; DRDC Toronto CR 2007-122. Defence R&D Canada – Toronto.

This document is the users manual for The fMRI Gambling Task developed by NTT Systems Inc. The fMRI Gambling Task is a computer software program that presents the subject with representations of two or more decks of cards, where each card has a numeric value associated with it. The task accumulates the value of the selected cards and the subject's goal is to make this value as large as possible. This version of the Gambling Task is designed for use in an fMRI environment. Consequently, a number of features have been added to manage timing considerations and input device characteristics.

Sommaire

Gambing Task (fMRI Revision 3.0.1)

[Marc Grushcow]; DRDC Toronto CR 2007-122. Defence R&D Canada – Toronto.

Le présent document constitue le manuel des utilisateurs du fMRI Gambling Task, réalisé par NTT Systems Inc. Le fMRI Gambling Task est un programme de logiciels informatiques qui présente au sujet des représentations de deux jeux de cartes ou plus, dont chacune des cartes a une valeur numérique qui lui est associée. La tâche consiste à accumuler la valeur des cartes choisies et le sujet vise à augmenter cette valeur autant que possible. La version de Gambling Task est conçue pour utilisation dans un environnement de d'IRMf (imagerie par résonance magnétique fonctionnelle). Par conséquent, un certain nombre de fonctions ont été ajoutées pour gérer les contraintes de temps et les caractéristiques des unités d'entrée.

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Introduction

The fMRI Gambling Task presents the user with two or more card decks laid out face down on the screen. Each card has a value associated with it that we will refer to as card value in this document. Card value is an integer number and it may assume a positive or negative value. It is displayed on the card face, along with some additional information that describes the context of the given value (e.g. *"$40"* or *"40 solders"*). The back of the card contains just an image.

The subject selects one of the decks and the top card's face is revealed. The experimenter may designate one or more decks so that one of their cards will also be revealed with each trial. This gives the subject information about these other decks. The cumulative total is updated with the selected card's value, and subject makes his or her next selection.

This version of the Gambling Task is designed for use when the subject is laying in an fMRI machine. Consequently, the various stages of each trial are synchronized with the fMRI scan cycle. The task controls the start time of the initial scan by signalling the fMRI machine by toggling all data lines on the parallel port. The fMRI scan cycle time is specified in an initialization file and the task assumes that cycle time is constant and stable. The subject indicates their deck choice via a special keyboard device connected to the computer via a USB port. The initialization file allows for a configurable relationship between keyboard keys and decks. The result data file produced for each run explicitly identifies each trial phase and user action. The fMRI scan cycle number as well as time into task is included in all cases.

Gambling Task borrows heavily from standard SUSOPS tasks. Its configuration options and result file format are consistent with other SUSOPS tasks. Thus the Gambling Task can run either as a stand-alone application or as an integral part of the SUSOPS platform.

Description of Gambling Task

Running the task

The Gambling Task requires ten (9) input parameters. They include:

1. An identifier used to represent the experiment as a whole (experiment ID).

2. An identifier used to represent the individual subject (subject ID).

3. The session number. This is used only with single user SUSOPS experiments (session number).

4. A string that identifies the task (task ID).

5. A block number. General only used with single user SUSOPS experiments (block number).

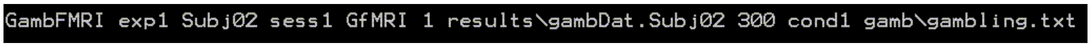
6. The name of the result file (e.g., gambdat.999, c:\results\gambdat.123, etc.) If an existing file is named, the task will append results.

7. Nominal task duration in seconds. Ignored by the task but used by the SUSOPS experiment editor.

8. A string that identifies the experimental condition (condition).

9. A file containing other configuration information (configuration file).

The above parameters have to be listed on the command line, in the above order and separated by an empty space (see figure below). Parameter values containing an empty space must be enclosed in quotation marks. It may be useful to create a batch file that would set most of the above parameters to default value.



```
GambFMRI exp1 Subj02 sess1 GfMRI 1 results\gambDat.Subj02 300 cond1 gamb\gambling.txt
```

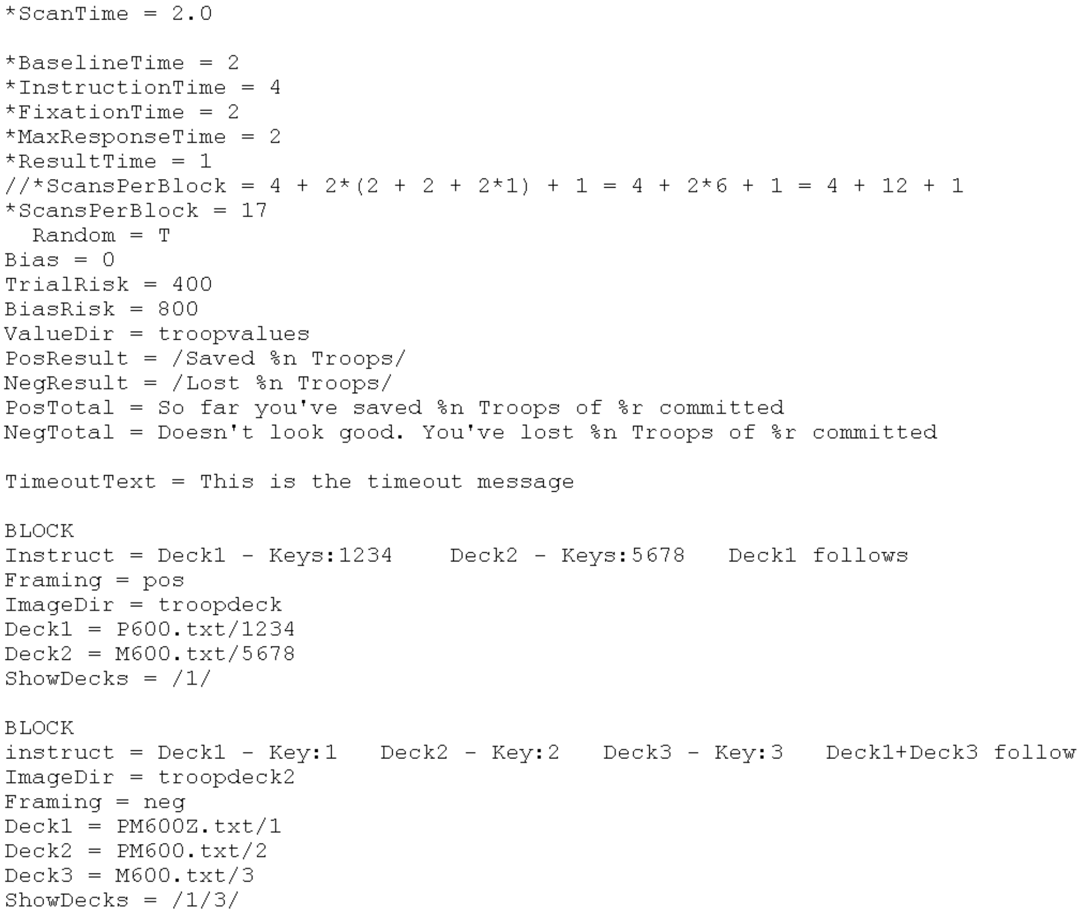
Figure 1. *Command Line parameters*

All command line parameters (except for block number and nominal duration) are considered strings and their format will not be checked. Block number and nominal duration must be integers.

Configuration parameters

Gambling Task's configuration parameters are specified in the configuration file. The name of this file is provided as the last command line parameter (see above). It may be given in either relative or absolute format, but all directories and files specified in it (see below) will be considered relative to the directory that contains the named configuration file..

The configuration file is a simple text file that contains actual information about the number of decks to display on the screen, the number of cards per deck and their values, as well as the context in which those values would be looked at.   The following figure shows such a file.



```
*ScanTime = 2.0

*BaselineTime = 2
*InstructionTime = 4
*FixationTime = 2
*MaxResponseTime = 2
*ResultTime = 1
//*ScansPerBlock = 4 + 2*(2 + 2 + 2*1) + 1 = 4 + 2*6 + 1 = 4 + 12 + 1
*ScansPerBlock = 17
  Random = T
Bias = 0
TrialRisk = 400
BiasRisk = 800
ValueDir = troopvalues
PosResult = /Saved %n Troops/
NegResult = /Lost %n Troops/
PosTotal = So far you've saved %n Troops of %r committed
NegTotal = Doesn't look good. You've lost %n Troops of %r committed

TimeoutText = This is the timeout message

BLOCK
Instruct = Deck1 - Keys:1234    Deck2 - Keys:5678   Deck1 follows
Framing = pos
ImageDir = troopdeck
Deck1 = P600.txt/1234
Deck2 = M600.txt/5678
ShowDecks = /1/

BLOCK
instruct = Deck1 - Key:1   Deck2 - Key:2   Deck3 - Key:3   Deck1+Deck3 follow
ImageDir = troopdeck2
Framing = neg
Deck1 = PM600Z.txt/1
Deck2 = PM600.txt/2
Deck3 = M600.txt/3
ShowDecks = /1/3/
```

Figure 2. *Configuration file*

Each line provides one configuration parameter and consists of a parameter name, followed by an equal sign and ends with a parameter value. Empty spaces before parameter names, after parameter values and around an equal sign will be ignored. Parameters may be specified in any order, however those beginning with an asterisk (“*”) must appear before the first “BLOCK” line.

Blank lines and lines beginning with “//” are ignored.

Parameters are interpreted as follows: Parameters beginning with an asterisk set values that are used for the entire duration of the task. Other parameters that appear before the first BLOCK statement can be thought of as default values. If a parameter is not present in a given block, the corresponding default value is used. Otherwise, the value specified in that block overrides the default.

The following is a description of configuration parameters and their expected values:

1. *ScanTime is the amount of time in seconds required for the fMRI machine to perform one scan. The program assumes that once started, scans are performed continuously, at a constant rate, and without interruption.

2. *BaselineTime is the number of scans during which a blank, black screen will be displayed. The baseline screen is displayed only once at the start of the task.

3. *InstructionTime is the number of scans that the instruction screen (black blank) will be displayed.

4. *FixationTime is the number of scans that the fixation screen (black screen with large green "X") will be displayed.

5. *MaxResponseTime is the number of scans during which the subject is allowed to make a deck selection.

6. *ResultTime is used to control three display durations (in scans): the time that the face of the selected deck is displayed; the time that any follower decks are displayed; and, the time that the final end of block summary screen is displayed.

7. *ScansPerBlock specified the number of scans allocated to each block including instruction presentation and block summary display. ***<u>NOTE</u>*****: *Proper operation of the task is critically dependent on setting *ScansPerBlock properly. This is discussed in Section "*Calculating *ScansPerBlock*" below.***

8. *Random specifies if cards in the deck should be randomized. "T" will randomize the cards and "F" will not.

9. Framing indicates how zero values are treated. If framing is positive ("pos") then the PosTotal or PosResult strings are displayed when the cumulative score or selected card value are equal to zero. If framing is negative ("neg") then NegTotal and NegResult strings are displayed when the cumulative score or selected card value are equal to zero.

10. Bias provides the starting value for the cumulative total. This value will be displayed at the bottom of the screen when the task starts and before any selection is made.

11. TrialRisk represents the number of units (troops, dollars, …) that are being risked with *each* draw. The total amount risked over the run is incremented by this amount with each draw.

12. BiasRisk represents the initial value of the cumulative risk.

13. ImageDir provides the name of directory that contains card images;

14. ValueDir provides the name of directory that contains value files; and

15. Deck<X> specifies the actual names of value files (these are files that contain card values in a given deck). <X> specifies the deck number and it has to start with number 1 (Deck1 is the first deck) and decks following the missing number (if there is any) will be ignored. The list of these Deck<X> parameters determines how many decks will be presented to the subject. One may have many value and image files in ImageDir and ValueDir directories, respectively, but if there are only Deck1, Deck2 and Deck3 entries in the configuration file, then only three decks will be presented in the task. The deck value file names are followed by a slash ("/") and a list of characters, not including spaces. In this version of the task, the subject selects decks via the keyboard, not the mouse. The character(s) following the slash on each line denote the characters that will select the corresponding deck.

16. ShowDecks identifies the decks that are always displayed with each trial. In the above example cards from decks 1 and three will be displayed with each trial. For example, if the subject selects deck 2, its card will be displayed first and then the cards from decks 1 and three will be displayed. If deck 1 is selected, its card will be displayed first and then the card from deck 3 will be displayed.

17. PosResult and NegResult specify phrases that are displayed on the selected card's face. PosResult is used for positive values and NegResult is used for negative values. The string "%n" is replaced with the absolute card value.

18. PosTotal and NegTotal specify phrases that are used to display the cumulative results over the run. "%n" is replaced with the cumulative total of selected cards and "%r" is replaced with the cumulative risk. Absolute values are used in all cases.

19. Each time the task is run, it will present a number of BLOCKs, as described below. The parameters that configure a BLOCK statement, along with needed default values, determine the task configuration for that block.

ImageDir and ValueDir have to exist in the gamb directory. The gamb directory must be a subdirectory of the directory that contains the configuration file.

Task Description

When the task starts it reads the entire configuration file and configures the parameters for each block. Once this has been done it signals the fMRI machine to begin the first scan and it then presents the *baseline phase* (black blank screen) for *BaselineTime scans. Following this it presents each block specified in the configuration file.

Each block consists of an *instruction phase* that runs for *InstructionTime scans, followed by a series of *trial phases*, followed by a *summary phase* that runs for *ResultTime scans. Each block is guaranteed to end in exactly *ScansPerBlock scan cycles.

Instruction Phase (*InstructionTime)

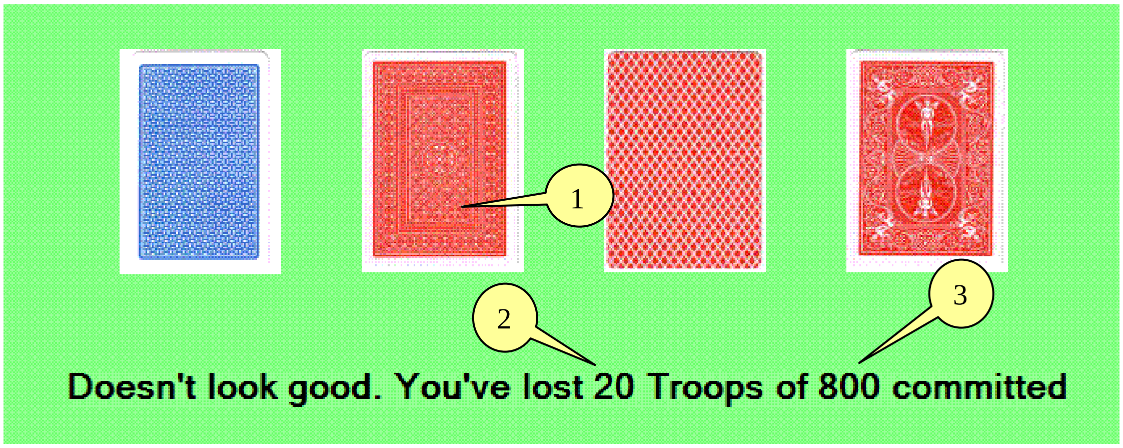
The text, specified by the Instruct configuration parameter is displayed for InstructionTime scans.

Fixation Phase (*FixationTime)

In this phase the subject is presented with a large green “X” centred in a black screen. There is no response and the phase ends FixationTime scans after it begins.

Deck Selection Phase (*MaxResponseTime)

During this phase the subject is presented with card decks as shown in the following figure. The phase lasts MaxResponseTime scans. During this time, the subject can make a choice by entering the associated input key on the keypad. Only the first response will be remembered and the selected deck will be highlighted with a blue frame.



Doesn't look good. You've lost 20 Troops of 800 committed

Figure 3. *Start Form*

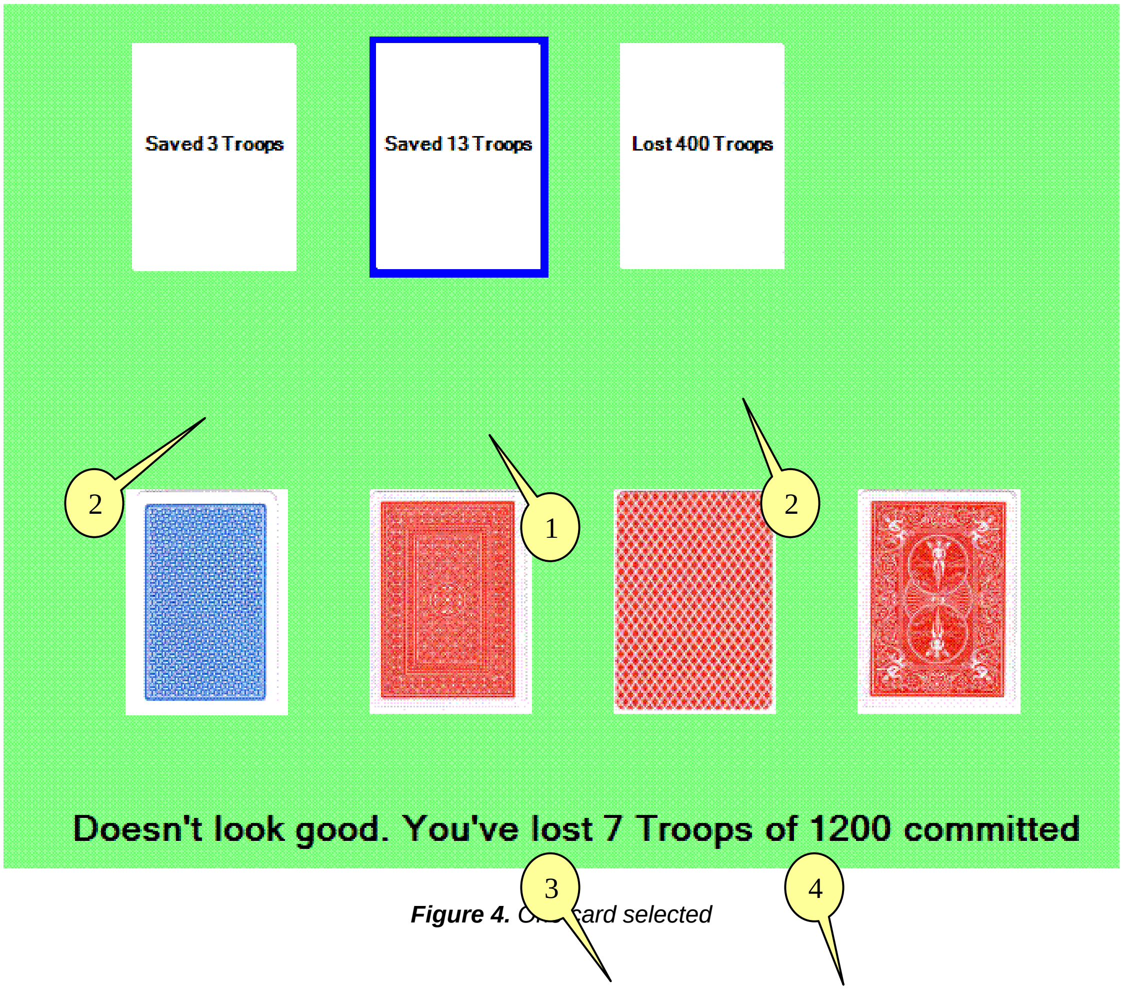
The initial bias (Figure 3:2) and BiasRisk (Figure 3:3) are configurable and may be set at any value.

Display Selected Card (*ResultTime)

When the subject selects a deck, the “top card” (Figure 3:1) reveals its face (Figure 4:1). The selected card is highlighted with a blue border. This phase lasts for ResultTime or (2 * ResultTime) scans. See **“**Calculating *ScansPerBlock**”** below.

Display Followers (*ResultTime)

Other cards from decks in the ShowDecks are then revealed (Figure 4:2). The total value is then updated (Figure 4:3) based on the selected card value and TrialRisk is added to the cumulative risk (Figure 4:4). This phase lasts for *ResultTime scans *iff* decks have been specified in the ShowDecks parameter. If not, this phase is skipped.



Saved 3 Troops

Saved 13 Troops

Lost 400 Troops

Doesn't look good. You've lost 7 Troops of 1200 committed

Figure 4. *One card selected*

The deck can never be empty. Cards are selected from the deck without replacement and if all cards are selected, the deck is restored to its initial (full) state. The task assumes that there are at least two values specified for each deck.

Each time the subject selects a card, the upper portion of the display is cleared before the selected card is displayed.

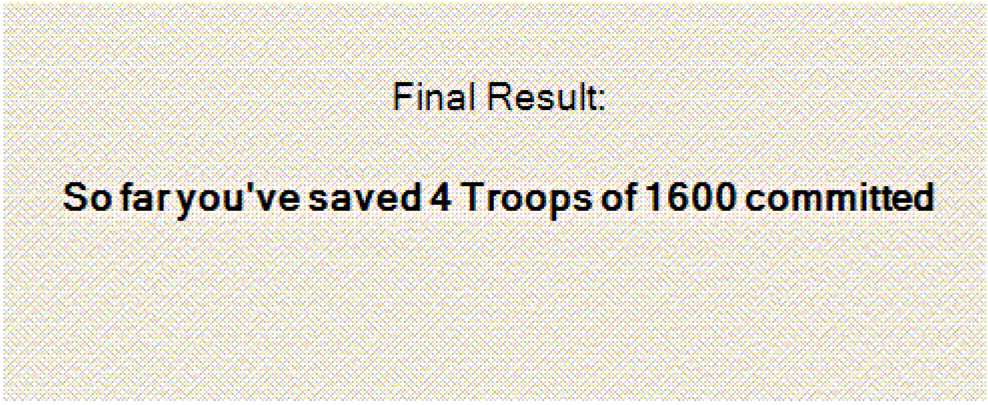
At this point, the program checks to see if the block has been running for *ScansPerBlock scan cycles. If not, it starts the next trial with a Fixation Phase. Otherwise, it proceeds to the Summary Phase.

Display Timeout (*ResultTime)

If the subject does not select a card within MaxResponseTime scans, the timeout message specified with the TimeoutText configuration parameter is displayed. This phase replaces the Display Selected Card and Display Followers phases. This phase lasts for ResultTime or (2 * ResultTime) scans. See **“**Calculating *ScansPerBlock**”** below.

Summary Phase (*ResultTime)

When the block has been completed, the cumulative results for the block are displayed as shown in the following figure. This phase lasts for *ResultTime scans.



Final Result:

So far you've saved 4 Troops of 1600 committed

Figure 5. *Final result*

Calculating *ScansPerBlock

ScansPerBlock can only be specified once and thus specifies the run time for each and every block. Each block consists of an *instruction phase*, $\boldsymbol{N_T}$ *trial phases*, and finally, a *summary phase*. Therefore, in general, ScansPerBlock should be set to:

ScansPerBlock = InstructionTime + $\boldsymbol{N_T}$ * *TrialTime* + ResultTime

where ***N*** is the desired number of trials in the block.

TrialTime is dependent on whether or not there are followers.

If ***there are no followers*** (ShowDecks not specified), each trial consists of a *Deck Selection phase*, and either a *Display Selected Card phase*, or a *Display Timeout phase*. In this case …

TrialTime = FixationTime + MaxResponseTime + ResultTime

If ***there are followers*** (ShowDecks is specified), each trial consists of a *Deck Selection phase*, and either (a *Display Selected Card phase* and a *Display Followers phase)*, or a *Display Timeout phase*. If the subject does not respond, the *Display Timeout phase* replaces both the *Display Selected Card* and the *Display Followers phase*. In either case …

TrialTime = FixationTime + MaxResponseTime + (2 * ResultTime)

There is a problem if there are ***blocks of both types*** in the configuration file since *TrialTime* would be different for different blocks. In this case, calculate *TrialTime* as …

TrialTime = FixationTime + MaxResponseTime + (2 * ResultTime)

Blocks with followers will work in the normal way. For blocks without followers, both the *Display Selected Card phase*, and the *Display Timeout phase* will be shown for
(2 * ResultTime) scan cycles.

In summary, if there are ***no blocks with followers in the entire configuration file***, calculate ScansPerBlock as …

ScansPerBlock = InstructionTime
+ $\boldsymbol{N_T}$ * *(*FixationTime + MaxResponseTime + ResultTime*)*
+ ResultTime

If there are ***any blocks with followers in the entire configuration file***, calculate ScansPerBlock as …

ScansPerBlock = InstructionTime
+ $\boldsymbol{N_T}$**(*FixationTime + MaxResponseTime + **2***ResultTime*)*
+ ResultTime

Overall task timing and state transitions are shown in the following diagram:

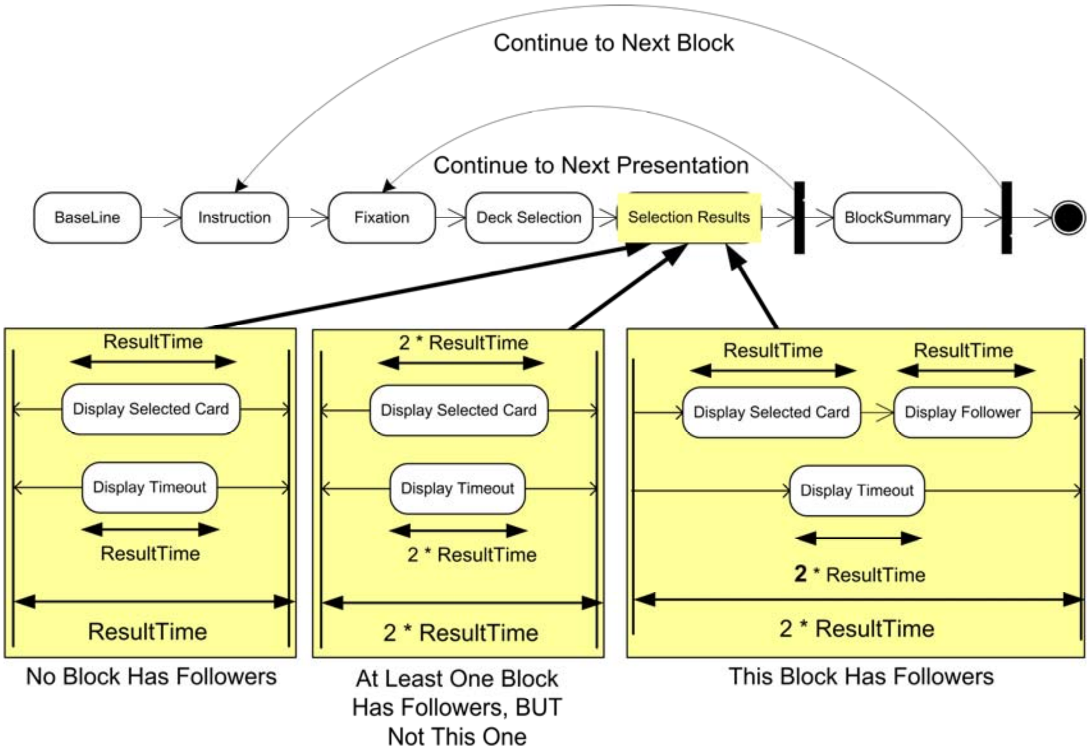


Figure 6. *Timing and State Transition Diagram*

Calculating Task Run Time

Task run time includes the time for all blocks plus the time for the initial *Baseline phase*. If a configuration file specifies $\boldsymbol{N_B}$ blocks, the total runtime in scan cycles is …

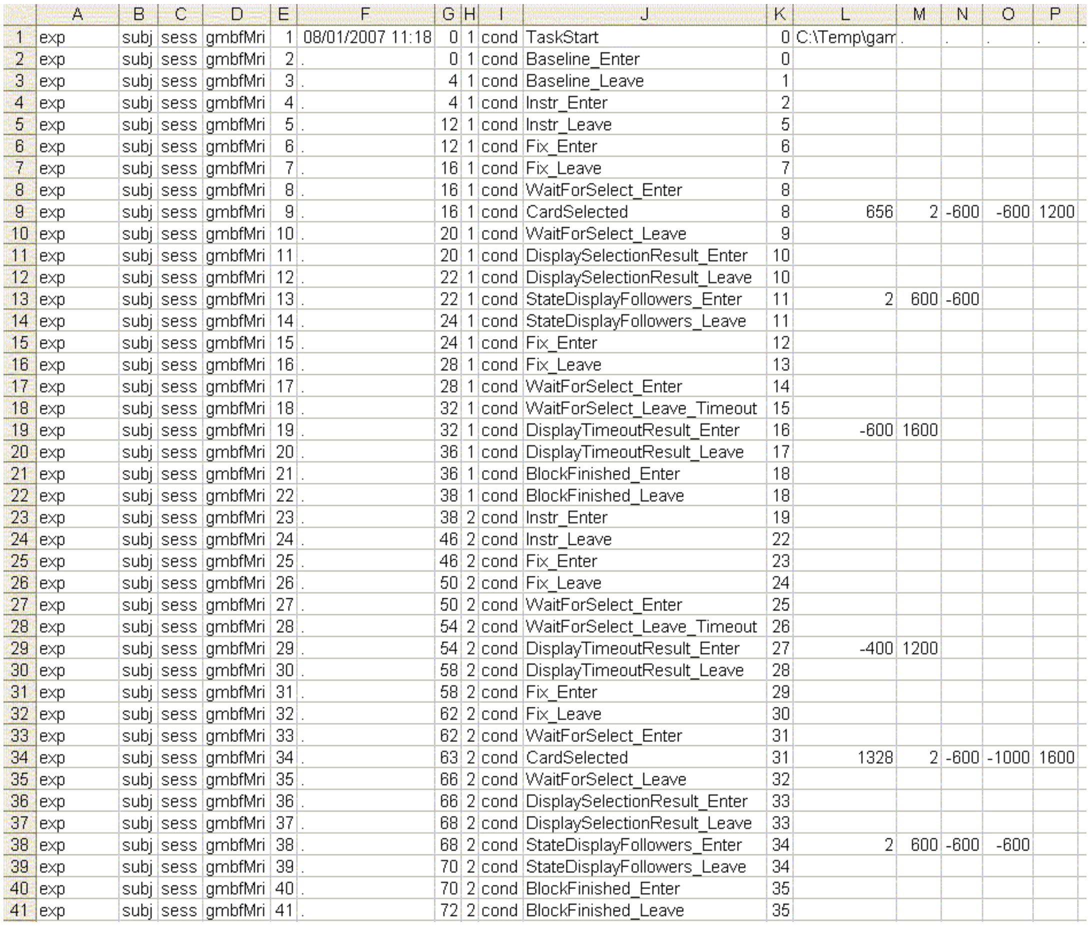
$$Runtime_{ScanCycles} = \text{BaselineTime} + \boldsymbol{N_B} * \text{ScansPerBlock}$$

The total runtime in seconds is …

$$Runtime_{Seconds} = Runtime_{ScanCycles} * \text{ScanTime}$$

Result File

Gambling Task produces a tab delimited file containing a record of all phase events and subject card selections. The following figure shows a sample data file loaded into Excel. Item numbers below identify the columns being described.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	
1	exp	subj	sess	gmbfMri	1	08/01/2007 11:18	0	1	cond	TaskStart	0	C:\Temp\gam	.	.	.	.	.
2	exp	subj	sess	gmbfMri	2	.	0	1	cond	Baseline_Enter	0						
3	exp	subj	sess	gmbfMri	3	.	4	1	cond	Baseline_Leave	1						
4	exp	subj	sess	gmbfMri	4	.	4	1	cond	Instr_Enter	2						
5	exp	subj	sess	gmbfMri	5	.	12	1	cond	Instr_Leave	5						
6	exp	subj	sess	gmbfMri	6	.	12	1	cond	Fix_Enter	6						
7	exp	subj	sess	gmbfMri	7	.	16	1	cond	Fix_Leave	7						
8	exp	subj	sess	gmbfMri	8	.	16	1	cond	WaitForSelect_Enter	8						
9	exp	subj	sess	gmbfMri	9	.	16	1	cond	CardSelected	8	656	2	-600	-600	1200	
10	exp	subj	sess	gmbfMri	10	.	20	1	cond	WaitForSelect_Leave	9						
11	exp	subj	sess	gmbfMri	11	.	20	1	cond	DisplaySelectionResult_Enter	10						
12	exp	subj	sess	gmbfMri	12	.	22	1	cond	DisplaySelectionResult_Leave	10						
13	exp	subj	sess	gmbfMri	13	.	22	1	cond	StateDisplayFollowers_Enter	11	2	600	-600			
14	exp	subj	sess	gmbfMri	14	.	24	1	cond	StateDisplayFollowers_Leave	11						
15	exp	subj	sess	gmbfMri	15	.	24	1	cond	Fix_Enter	12						
16	exp	subj	sess	gmbfMri	16	.	28	1	cond	Fix_Leave	13						
17	exp	subj	sess	gmbfMri	17	.	28	1	cond	WaitForSelect_Enter	14						
18	exp	subj	sess	gmbfMri	18	.	32	1	cond	WaitForSelect_Leave_Timeout	15						
19	exp	subj	sess	gmbfMri	19	.	32	1	cond	DisplayTimeoutResult_Enter	16	-600	1600				
20	exp	subj	sess	gmbfMri	20	.	36	1	cond	DisplayTimeoutResult_Leave	17						
21	exp	subj	sess	gmbfMri	21	.	36	1	cond	BlockFinished_Enter	18						
22	exp	subj	sess	gmbfMri	22	.	38	1	cond	BlockFinished_Leave	18						
23	exp	subj	sess	gmbfMri	23	.	38	2	cond	Instr_Enter	19						
24	exp	subj	sess	gmbfMri	24	.	46	2	cond	Instr_Leave	22						
25	exp	subj	sess	gmbfMri	25	.	46	2	cond	Fix_Enter	23						
26	exp	subj	sess	gmbfMri	26	.	50	2	cond	Fix_Leave	24						
27	exp	subj	sess	gmbfMri	27	.	50	2	cond	WaitForSelect_Enter	25						
28	exp	subj	sess	gmbfMri	28	.	54	2	cond	WaitForSelect_Leave_Timeout	26						
29	exp	subj	sess	gmbfMri	29	.	54	2	cond	DisplayTimeoutResult_Enter	27	-400	1200				
30	exp	subj	sess	gmbfMri	30	.	58	2	cond	DisplayTimeoutResult_Leave	28						
31	exp	subj	sess	gmbfMri	31	.	58	2	cond	Fix_Enter	29						
32	exp	subj	sess	gmbfMri	32	.	62	2	cond	Fix_Leave	30						
33	exp	subj	sess	gmbfMri	33	.	62	2	cond	WaitForSelect_Enter	31						
34	exp	subj	sess	gmbfMri	34	.	63	2	cond	CardSelected	31	1328	2	-600	-1000	1600	
35	exp	subj	sess	gmbfMri	35	.	66	2	cond	WaitForSelect_Leave	32						
36	exp	subj	sess	gmbfMri	36	.	66	2	cond	DisplaySelectionResult_Enter	33						
37	exp	subj	sess	gmbfMri	37	.	68	2	cond	DisplaySelectionResult_Leave	33						
38	exp	subj	sess	gmbfMri	38	.	68	2	cond	StateDisplayFollowers_Enter	34	2	600	-600	-600		
39	exp	subj	sess	gmbfMri	39	.	70	2	cond	StateDisplayFollowers_Leave	34						
40	exp	subj	sess	gmbfMri	40	.	70	2	cond	BlockFinished_Enter	35						
41	exp	subj	sess	gmbfMri	41	.	72	2	cond	BlockFinished_Leave	35						

Figure 7. *Results imported into Excel*

A. Experiment Identifier as provided in the command line.

B. Subject Identifier as provided in the command line.

C. Session Identifier as provided in the command line.

D. Task Identifier as provided in the command line.

E. Record number within run.

F. Task start date (dd/mm/yy) and time (hh:mm (24 hr.)). This appears only on the first record of a run. Subsequent records contain only a “.”.

G. Time of record as seconds into run.

H. Block Number within run.

I. Condition Identifier as provided on the command line.

J. Event Identifier

K. Scan Number (zero origin). For all “Enter” events, the record is written at the start of the specified scan. For all “Leave” events, the record is written at the end of the specified scan.

Certain events contain information in subsequent columns as follows:

TaskStart

- The file name of the configuration file.

CardSelected

- Subject “think time” in milliseconds from the time the decks were displayed until they made a selection.
- The deck number selected.
- The values of the top card on each deck at the time of the selection, ordered left to right as they appeared to the subject.
- The subject’s cumulative total based on their selections.
- The cumulative risked total, i.e., BiasRisk + (current number of trials) * TrialRisk

DisplayTimeoutResult_Enter

- The subject’s cumulative total based on their selections.
- The cumulative risked total, i.e., BiasRisk + (current number of trials) * TrialRisk

StateDisplayFollowers_Enter

- Deck Number of the selected deck.
- The values of all cards that were displayed to the subject on the top row of cards after the selection. This includes the selected card and the top card from all decks designated as “followers” in the BLOCK parameters. There is one output column for each deck whether or not a card value was displayed for that deck. In the case where a deck was not selected and was not designated as a follower, the column will contain a “.”.

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(U) The fMRI Gambling Task is a program that presents the subject with two or more decks of cards, where each card has a value associated with it. The task accumulates the value of the selected cards and the subject's goal is to make this value as large as possible. This version of the Gambling Task is designed for use in an fMRI environment. Consequently, a number of features have been added to manage timing considerations and input device characteristics.

(U) Le présent document constitue le manuel des utilisateurs du fMRI Gambling Task, réalisé par NTT Systems Inc. Le fMRI Gambling Task est un programme de logiciels informatiques qui présente au sujet des représentations de deux jeux de cartes ou plus, dont chacune des cartes a une valeur numérique qui lui est associée. La tâche consiste à accumuler la valeur des cartes choisies et le sujet vise à augmenter cette valeur autant que possible. La version de Gambling Task est conçue pour utilisation dans un environnement de d'IRMf (imagerie par résonance magnétique fonctionnelle). Par conséquent, un certain nombre de fonctions ont été ajoutées pour gérer les contraintes de temps et les caractéristiques des unités d'entrée.

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(U) gambling task, fMRI